CLAIMS

Having thus described the aforementioned invention, we claim:

1.     A method for improving spatial resolution using on-line depth-of-interaction (DOI) rebinning in a hybrid Positron Emission Tomography (PET)/Single Photon Emission Computed Tomography (SPECT) system running in PET-mode, the PET/SPECT system having a rotating dual-head tomograph using LSO/NaI scintillators and being capable of depth-of-interaction (DOI) measurement, the tomograph defining a field of view (FOV) within a patient gantry, said method comprising the steps of:

(a)     acquiring a PET coincidence data stream from a patient scan;

(b)     delivering the PET coincidence data stream to an on-line rebinner to derive a bin address output stream;

(c)     deriving a bin address output stream in said on-line rebinner from said PET coincidence data stream;

(d)     delivering the bin address output stream from the rebinner to a Fibre Channel PCI DMA receiver card for direct PCI DMA stream transfers;

(e)     histogramming the bin address output stream; and

(f)     storing said bin address output stream.

2.     The method of Claim 1 wherein said on-line rebinner is integrated within a rebinner circuitry which supports on-line real-time DOI line of response (LOR)-to-projection-space nearest-neighbor rebinning, and wherein DOI and gamma interaction centroid depth knowledge about LOR positioning is applied in real time.

3.     The method of Claim 1 wherein said step of deriving said bin address output stream includes performing a transaxial computation to determine at least a sinogram angle and a radial offset of a coincidence event between a first detector having coordinates ($x_A$, $y_A$) of a first detector head and a second detector having coordinates ($x_B$, $y_B$) of a second detector head, wherein said sinogram angle is determined by the equation:

$$sa = \tan^{-1} \left[ \frac{y_b - y_a}{x_b - x_a} \right] ,$$

and where said radial offset is determined by the equation:

$$ro = \sqrt{(x_a^2 + y_a^2)} * \sin(\tan^{-1}(y_a / x_a) - sa) .$$

4.     The method of Claim 1 further comprising the step of measuring a Gamma centroid location including the steps of:

(1)     rastering assumed transaxial and radial head positions and a corresponding rebinning map for optimal back-

projected image resolution, said step rastering using variables $r_A$, $t_A$, $r_B$, $t_B$ to represent radial and transaxial offsets for each head of the dual-head tomograph; and

(2)     stepping the values for $r_A$, $t_A$, $r_B$, $t_B$ discretely through a chosen range, with all combinations of the variables being tested.

5.     The method of Claim 1 further comprising the step of finding an optimal position of each head of the dual-head tomograph including the steps of:

(1)     collecting a 64-bit list mode file;

(2)     assuming a crystal position as the centroid for each head; and

(3)     defining a sequence for varying the assumed crystal positions.

6.     The method of Claim 5 wherein said sequence for varying the assumed crystal positions includes the steps of:

(i)     making at least one rebinning look up table;

(ii)    rebinning list mode data;

(iii)   histogramming and reconstructing the image;

(iv)    assessing image resolution using Full Width Half Maximum (FWHM) resolution;

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      (v)      recording a best resolution number and an associated trial position variable; and

      (vi)     repeating said steps of rebinning list mode data through said step of recording a best resolution number and an associated trial position variable on a subsequent trial variable set.

      7.     The method of Claim 6, in said step of assessing image resolution, wherein all FWHM resolution numbers are assessed from a conventional 2-D filtered back projection of the sinogram using a ramp filter with a 0.5 cutoff.

      8.     The method of Claim 6, in said step of assessing image resolution, wherein both image horizontal and vertical FWHM assessments are performed.

      9.     The method of Claim 6 further comprising the step of defining a final rebinning look-up table to be applied for general use, including for LOR which do not serve the FOV center.

      10.    A method for improving spatial resolution using on-line depth-of-interaction (DOI) rebinning in a hybrid Positron Emission Tomography (PET)/Single Photon Emission Computed Tomography

(SPECT) system running in PET-mode, the PET/SPECT system having a

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rotating dual-head tomograph using LSO/NaI scintillators and being

capable of depth-of-interaction (DOI) measurement, the tomograph

defining a field of view (FOV) within a patient gantry, said method

comprising the step of:

finding multiple gamma interaction centroid locations which are

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unique for different line of response (LOR) incident angles.